COMMUNITY DEVELOPMENT DEPARTMENT

CITY OF SANTA BARBARA SEA LEVEL RISE ADAPTATION PLAN SUBCOMMITTEE

November 19, 2019

Agenda

A. Adaptation recommendations for the low-lying flood areas (cont.)
B. Adaptation recommendations for the Harbor and Stearns Wharf
C. Scenario modeling and economic analysis

ADAPTATION RECOMMENDATIONS: LOW-LYING FLOOD AREAS

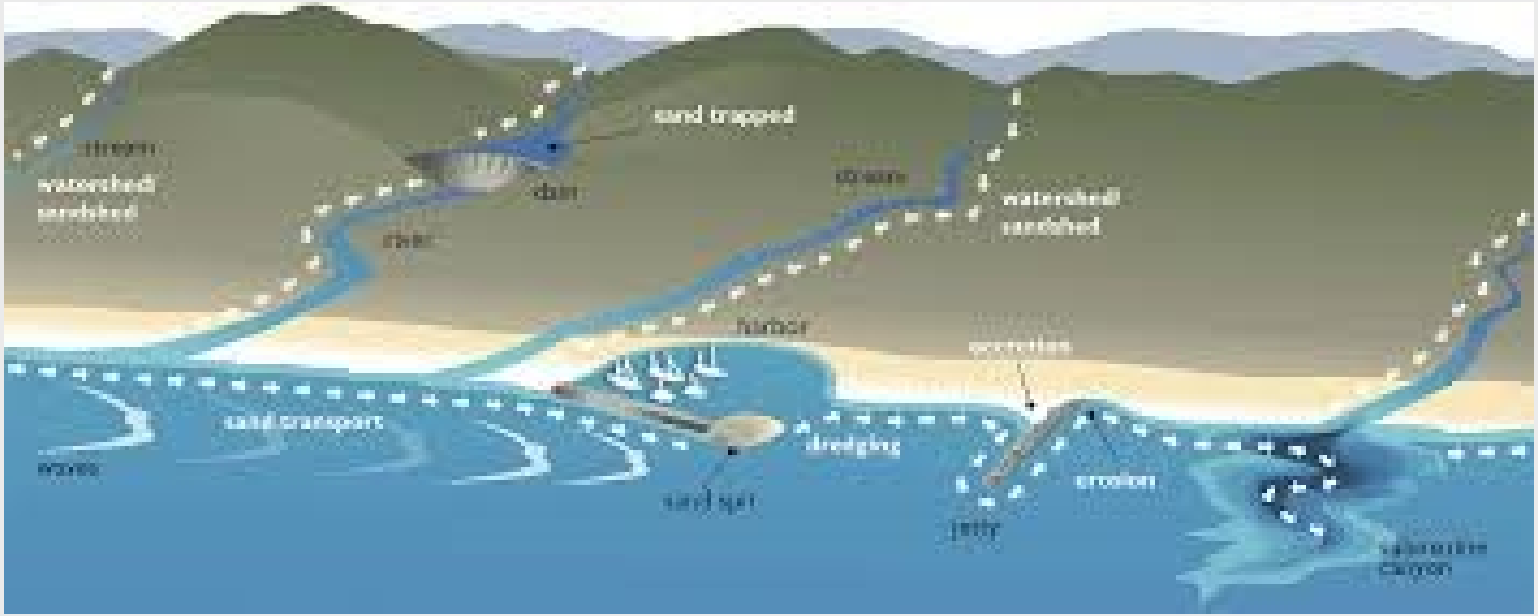
(Continued from last meeting)

Santa Barbara Littoral Cell

- Longshore Sediment Transport.
- Coastal Storms

Map of Santa Barbara Littoral Cell

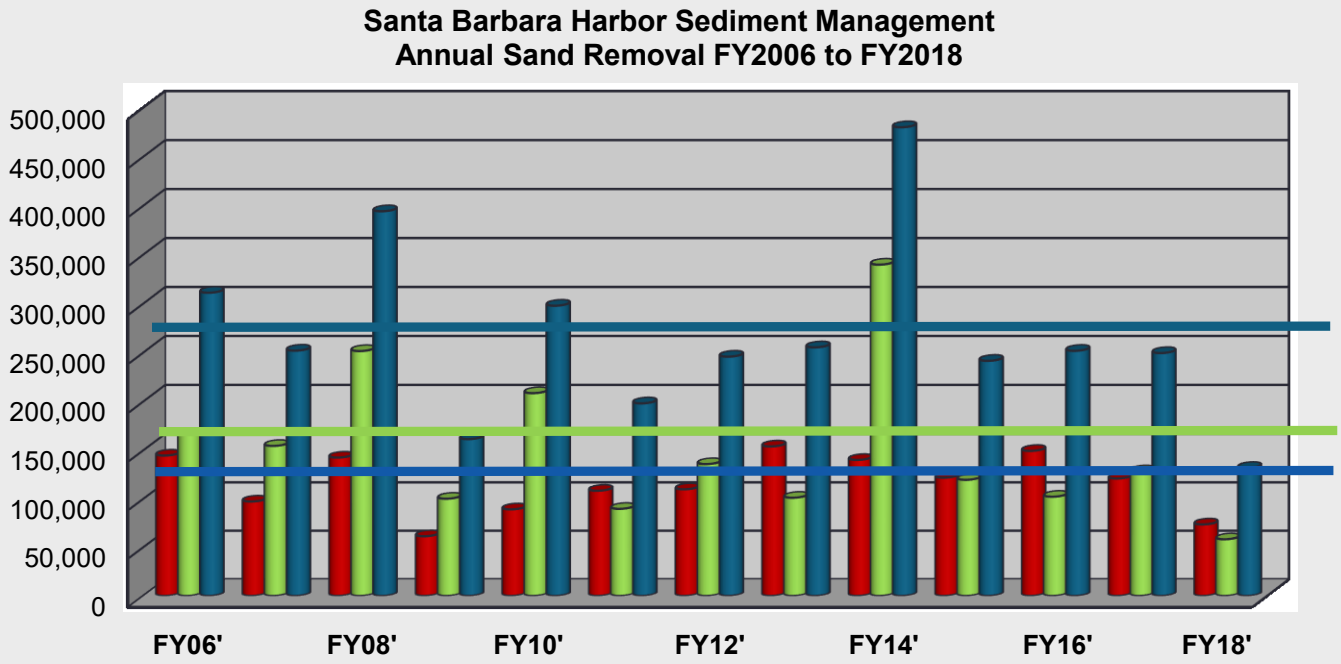
Map of Santa Barbara Littoral Cell



Longshore Sediment Transport

- Sand Bypassing (Army Corps dredging)
- Maintains equilibrium when fully funded
- Significant variability from year-to-year

Corps Dredging



Total Avg.
267,201 cu yd

Spring Avg.
150,638 cu yd

Fall Avg.
116,563 cu yd

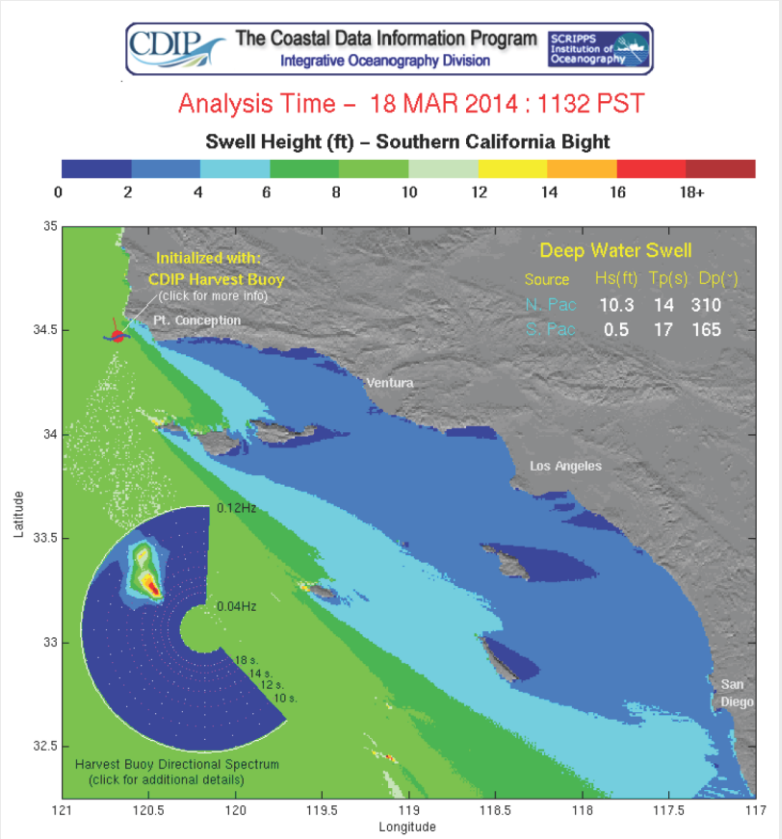
East Beach and West Beach

- Would not exist without Harbor dredging
- West beach accretes during SE storms
- West beach sand “trapped” within wave shadow of Harbor

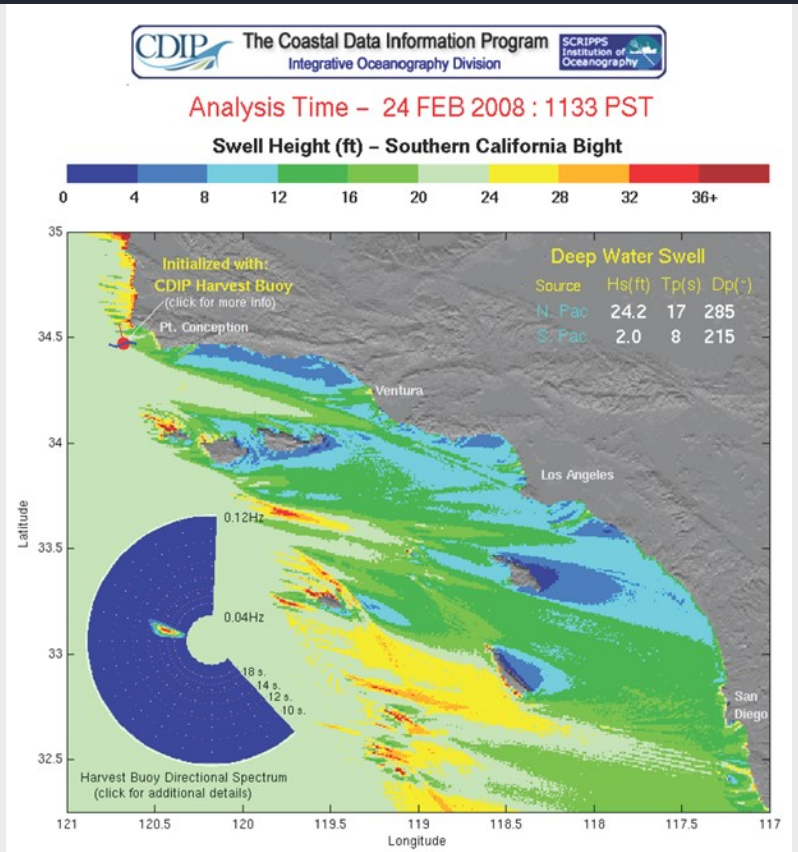
Coastal Storms

- Impacts from large swell include:
  - Erosion, overtopping, sand transport
- Swell factors
  - Height, angle, period
- Tidal amplitude

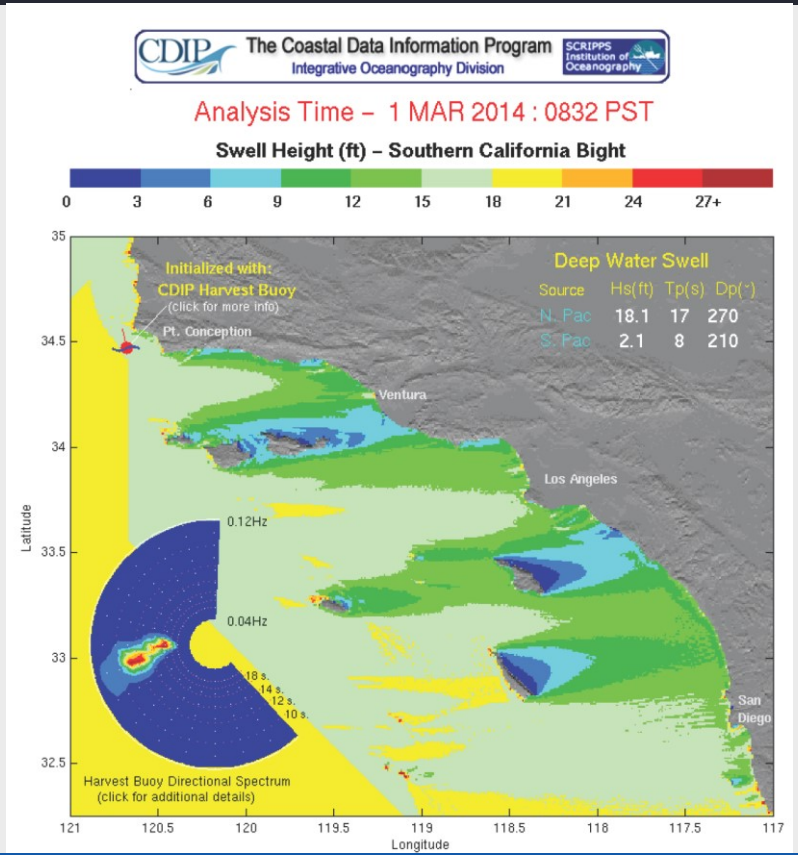
CDIP Swell Models



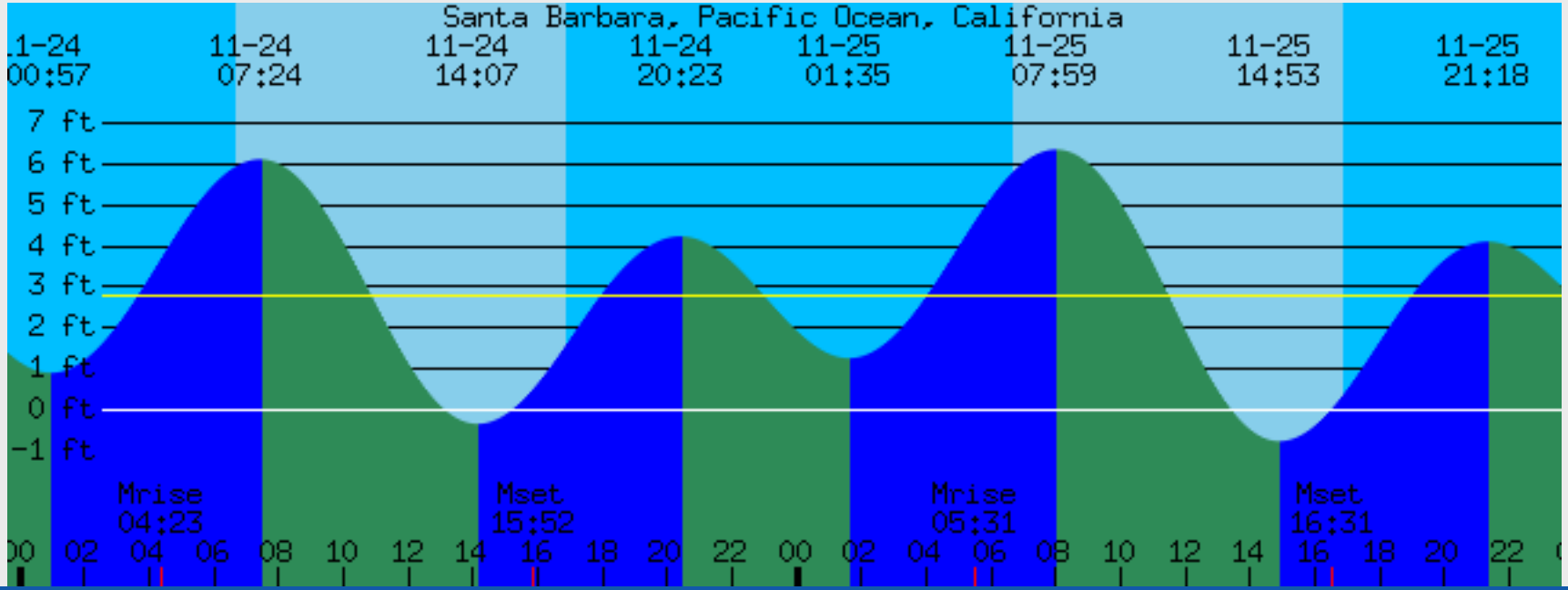
CDIP Swell Models



CDIP Swell Models



Tidal Amplitude Image



Low Lying Area Vulnerability Examples

- SLR increases frequency and severity

Low Lying Area Vulnerability Examples

Low Lying Area Vulnerability Examples

Low Lying Area Vulnerability Examples

Low Lying Area Vulnerability Examples

Low Lying Area Adaptation Strategies (near-term)

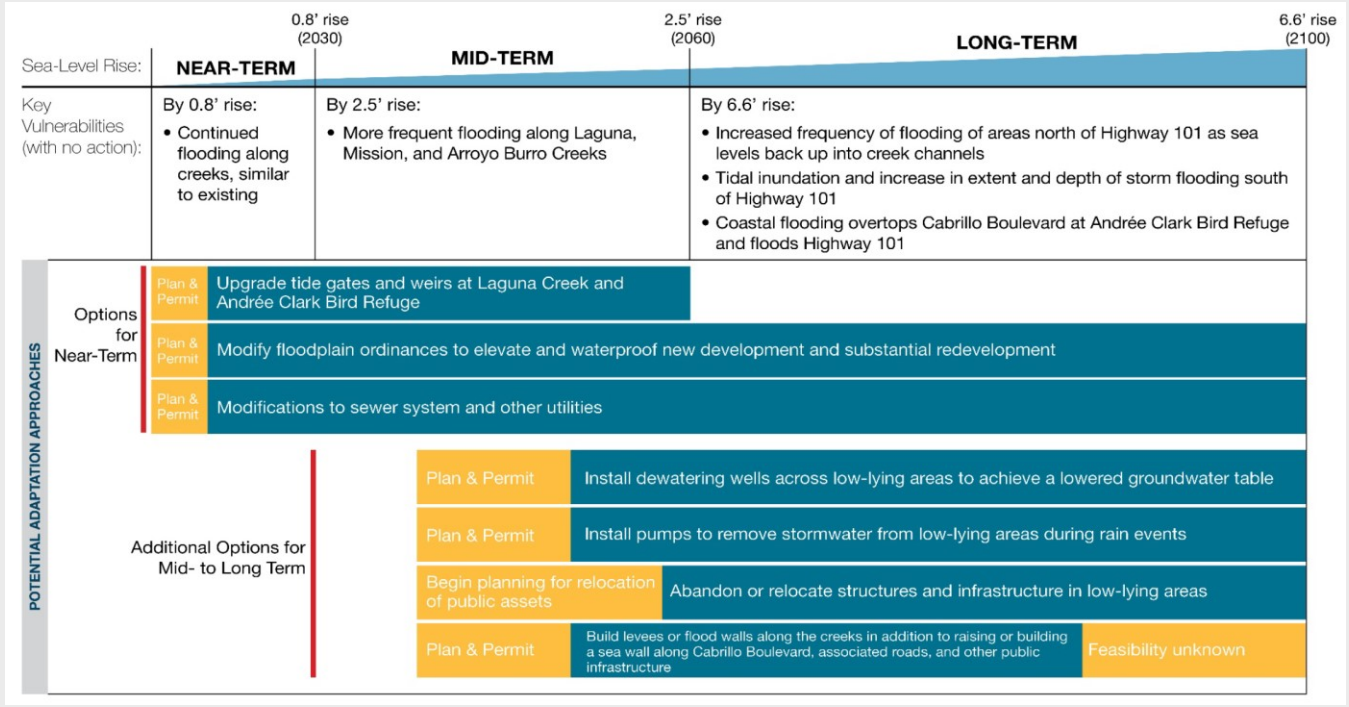
- Berms (S.B.Y.C, Carpinteria, Seal Beach)
- Dune restoration
- Source = West Beach?

Low Lying Area Adaptation Strategies (near-term)

Low Lying Area Adaptation Strategies (mid-term)

- Groins (Pierpont groin field)
- Requires backfilling (from West Beach or import)
- Maintain and raise existing shoreline protection

Flood Area Adaptation Framework



Recommended Near-Term Actions

- Reconstruct and possibly relocate the Laguna tide gate and pump system.
- Conduct a study to assess extreme rainfall runoff and creek discharge flooding in Laguna Channel with climate change and sea-level rise.

Recommended Near-Term Actions

- Improve the existing tide gate and weirs at Andree Clark Bird Refuge (in progress). Conduct a study to assess impacts of sea-level rise on Andree Clark Bird Refuge.
- Evaluate City's floodplain ordinance for new development and redevelopment in flooding areas impacted by sea-level rise, particularly south of Highway 101

Recommended Near-Term Actions

- Initiate study of changes in flooding as a result of:
  - *Fluvial flood events interacting with higher sea levels and*
  - *Changes in rainfall and fluvial flooding due to climate change.*
- Develop monitoring and adaptation thresholds for creek flooding.

Recommended Near-Term Actions

- Conduct a study to analyze existing groundwater elevations, the freeboard from typical levels, and potential impacts of sea-level rise. Study the feasibility of groundwater pumping to lower the water table.
- Study feasibility of creek floodwalls, tide gates, continuous seawall, levees, or other measures to prevent inundation and storm flooding.

Major Infrastructure Near-Term Actions

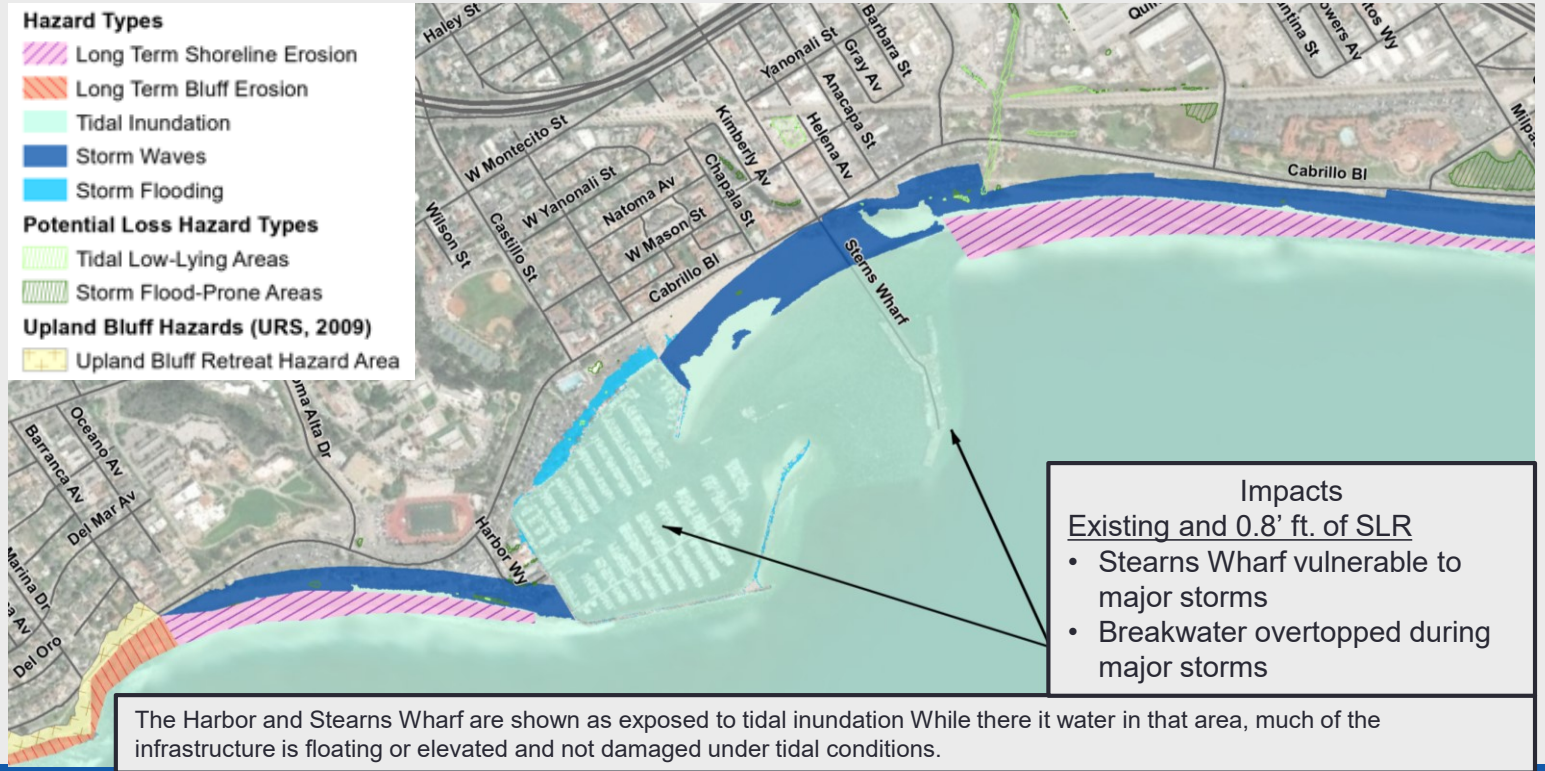
- Initiate a study of options for the wastewater system including redesign of system, adaptation options for El Estero Water Resource Center, and possible service point improvements.

Major Infrastructure Near-Term Actions

- Coordinate with electrical and natural gas utility providers to assess impact to energy transmission and distribution systems
- Initiate study of potential impacts to the storm water system

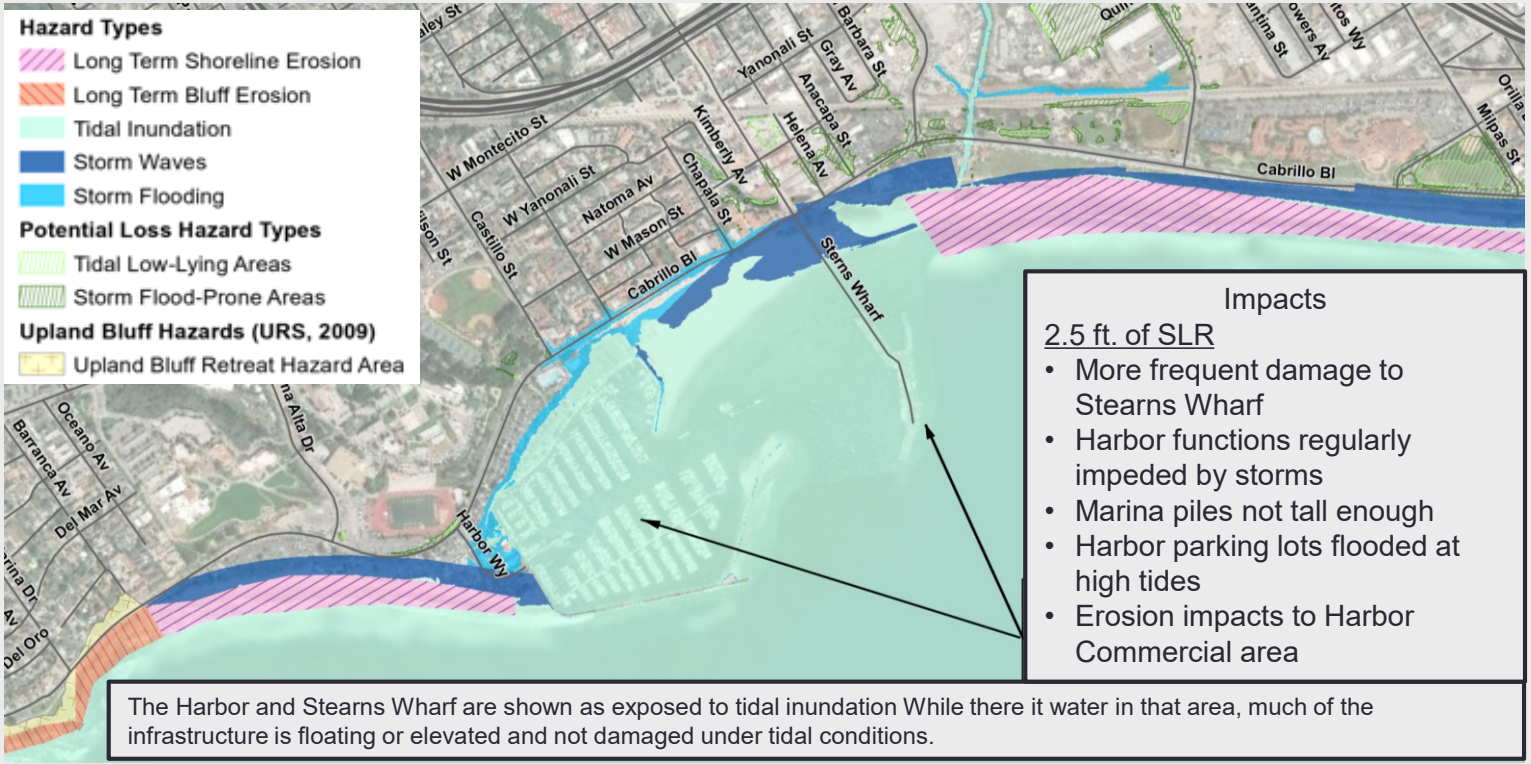
ADAPTATION RECOMMENDATIONS: HARBOR AND STEARNS WHARF

0.8 ft SLR Hazard Map: Harbor and Stearns Wharf



The Harbor and Stearns Wharf are shown as exposed to tidal inundation While there it water in that area, much of the infrastructure is floating or elevated and not damaged under tidal conditions.

2.5 ft SLR Hazard Map: Harbor and Stearns Wharf



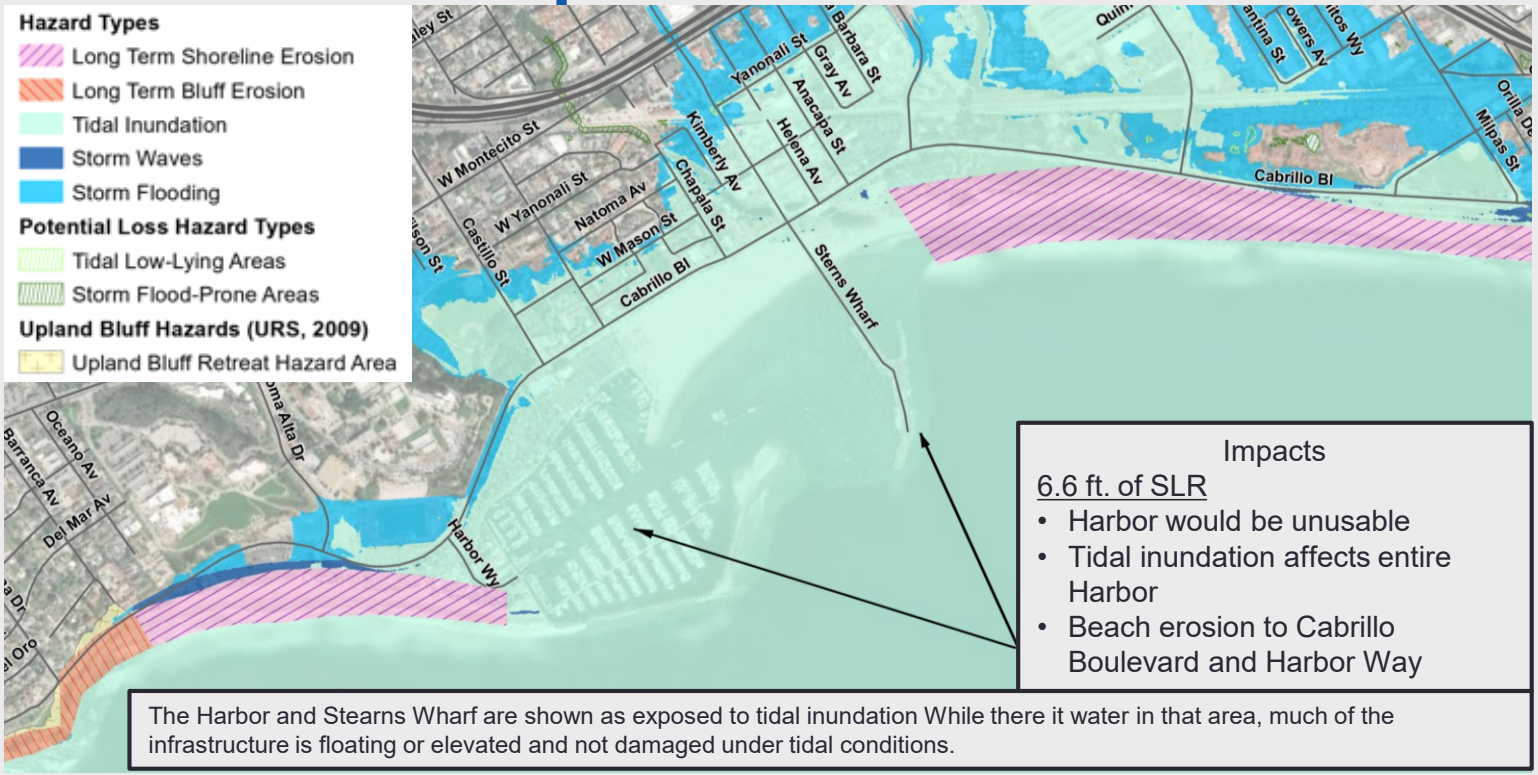
Impacts

2.5 ft. of SLR

- More frequent damage to Stearns Wharf
- Harbor functions regularly impeded by storms
- Marina piles not tall enough
- Harbor parking lots flooded at high tides
- Erosion impacts to Harbor Commercial area

The Harbor and Stearns Wharf are shown as exposed to tidal inundation While there it water in that area, much of the infrastructure is floating or elevated and not damaged under tidal conditions.

6.6 ft SLR Hazard Map: Harbor and Stearns Wharf



The Harbor and Stearns Wharf are shown as exposed to tidal inundation While there it water in that area, much of the infrastructure is floating or elevated and not damaged under tidal conditions.

Harbor Vulnerability Examples

- Wave overtopping seawall in front of SBYC
- Guide piles in marina (photo)
- Harbor commercial flooding (photo)
- Breakwater cap vs. sandspit

Harbor Vulnerability Examples

Harbor Vulnerability Examples

Harbor Vulnerability Examples

Harbor Vulnerability Examples

Harbor Vulnerability Examples

Harbor Adaptation Strategies (near-term)

- Raise height of breakwater
- Reconstruct marinas with higher guide piles
- Initiate Corps study of cap on sandspit and rock groin

Harbor Adaptation Strategies (mid-term)

- Construct cap on sandspit and rock groin
- Raise height of breakwater and sidewalk
- Raise wave runup wall

Harbor Adaptation Strategies (long-term)

- Expand harbor to provide fill for raising grades:
  - Excavate Launch Ramp parking expanding harbor
  - Raise Harbor Commercial area and parking
  - 1 acre excavation raises 4 acres up to 6 feet

Stearns Wharf Vulnerability Example

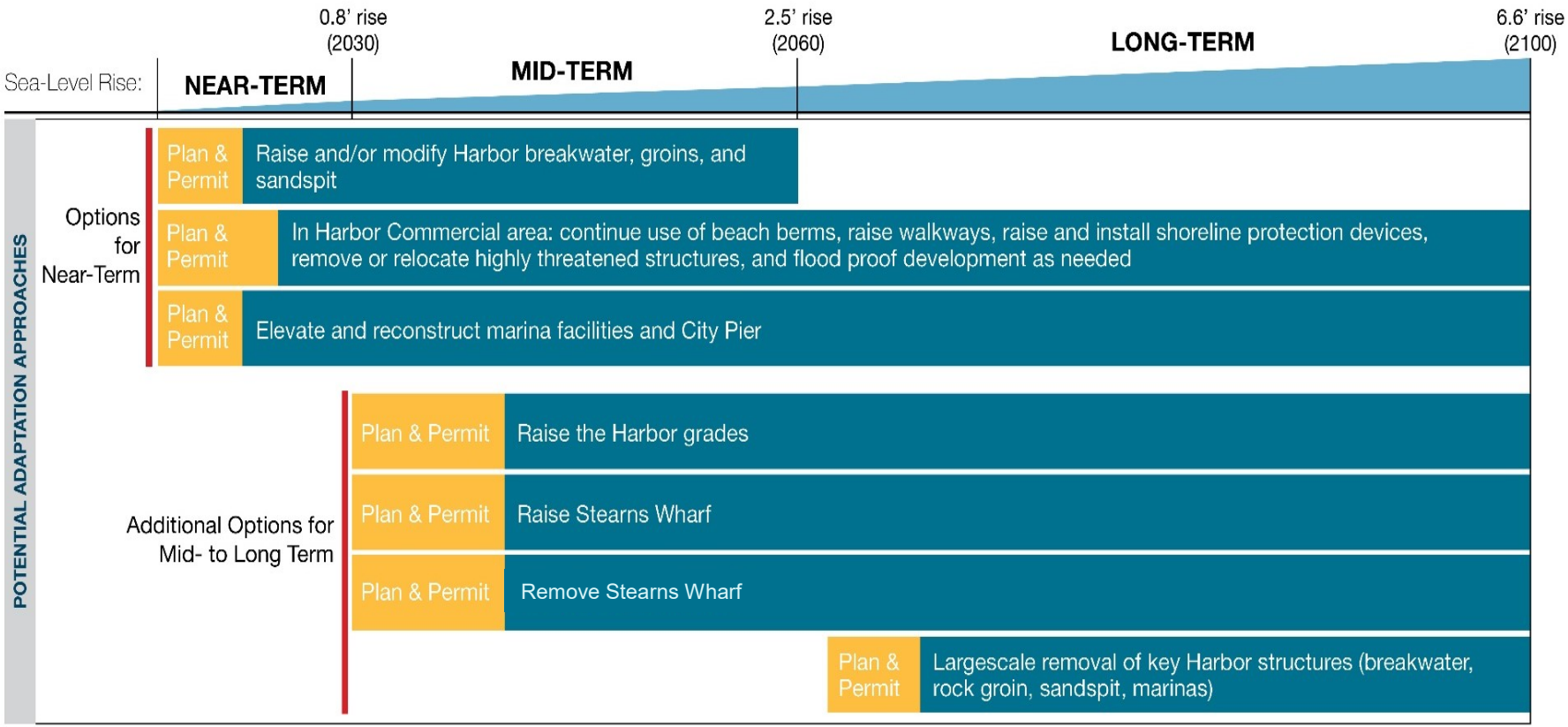
Stearns Wharf Adaptation Strategies (short-term)

Raise section destroyed by fire or storms

- Moby Dick Restaurant
- Monitor SLR – Prepare alternatives analysis with documented SLR of 0.5’

Stearns Wharf Adaptation Strategies (mid and long-term)

- Contingent on access to foot of Wharf


0.8' rise (2030)
2.5' rise (2060)
6.6' rise (2100)
Sea-Level Rise:
NEAR-TERM
MID-TERM
LONG-TERM
POTENTIAL ADAPTATION APPROACHES
Options for Near-Term
Plan & Permit
Raise and/or modify Harbor breakwater, groins, and sandspit
Plan & Permit
In Harbor Commercial area: continue use of beach berms, raise walkways, raise and install shoreline protection devices, remove or relocate highly threatened structures, and flood proof development as needed
Plan & Permit
Elevate and reconstruct marina facilities and City Pier
Additional Options for Mid- to Long Term
Plan & Permit
Raise the Harbor grades
Plan & Permit
Raise Stearns Wharf
Plan & Permit
Remove Stearns Wharf
Plan & Permit
Largescale removal of key Harbor structures (breakwater, rock groin, sandspit, marinas)

SCENARIO MODELLING AND ECONOMIC ANALYSIS

Adaptation Scenario Analysis

- Comparison of "No Action" with two potential adaptation scenarios
  - *Protect and Retreat/Protect Hybrid Scenarios*
  - *Not intended as proposed or preferred approach*
  - *Bracket a wide-range of possible actions*
- Economic benefit-cost analysis or scenarios
  - *Compares relative costs/benefits of "No Action" with adaptation*
  - *Provides high-level understanding of costs/benefits of adapting*

Scenario Analyzed: East City

Near-term (0-0.8 ft .SLR)	• Continue existing sand bypassing • Laguna Creek tide gate/pump improvements • Additional beach nourishment at East beach
Mid-Term (0.8- 2.5 ft SLR)	• Additional beach nourishment at Leadbetter beach • Relocate wastewater and infrastructure under beach. • Construct seawall segment along bike path from Harbor to East beach public restroom • Raise lands surrounding harbor above tidal inundation, raise bulkheads, groins, and breakwater. Rebuild marina facilities. • Floodwalls up Mission and Sycamore Creeks • Rebuild and raise Stearns Wharf

Scenario Analyzed: East City

Long-Term (2.5-6.6 ft. SLR)	• Construct/extend seawall east along East beach to Clark Estate along bike path • Reconstruct tide gate and add pump station at Andree Clark Bird Refuge • Raise lands around harbor above tidal inundation • Raise Leadbetter parking lot. • Dewater with groundwater wells and pumps along section of Shoreline Drive behind harbor. • Expand floodwalls up Mission and Sycamore Creeks • Dewatering wells and pumps to manage rising groundwater in low-lying flood areas. • Maintain/upgrade Stearns Wharf

Scenarios Analyzed: West City

	Protect Scenario	Retreat/Protect Hybrid Scenario
Near-term (0 0.8 feet SLR)	• Armor existing bluff toe and face with revetments to protect private structures • Allow erosion at bluff-top open spaces to allow beaches to persist	• Allow erosion at parcels to allow beaches to persist • Armor bluff toe at select spots on Shoreline Dr.
Mid-term (0.8-2.5 ft. SLR))	• Armor bluff toe along Shoreline Park. • Allow erosion of Douglas Family Preserve.	• Retreat parcels at risk of damage from bluff erosion • Armor bluff toe at spots on Shoreline Dr. and Cliff Dr. • Allow erosion of Douglas Family Preserve.

Potential Adaptation Analyzed, West City

	Protect Scenario	Retreat/Protect Hybrid Scenario
Long-term (2.5-6.6 ft. SLR)	• Build floodwall to protect Cliff Dr. from storm flooding at Arroyo Burro Creek with reconfiguration of parking • Allow erosion of bluff-top open space at Douglas Family Preserve.	• Armor Shoreline Dr. and Cliff Dr. while preserving 25-foot wide seaward area for lateral public access. • Raise Cliff Dr. at Arroyo Burro Ck. on fill and accommodate storm flooding of parking • Allow erosion of bluff-top open space at Douglas Family Preserve.

Santa Barbara Sea Level Rise Adaptation Plan: Local Coastal Program Update

Economic Analysis

Aaron McGregor

Senior Associate, Sustainable Economic Practice

November 19, 2019

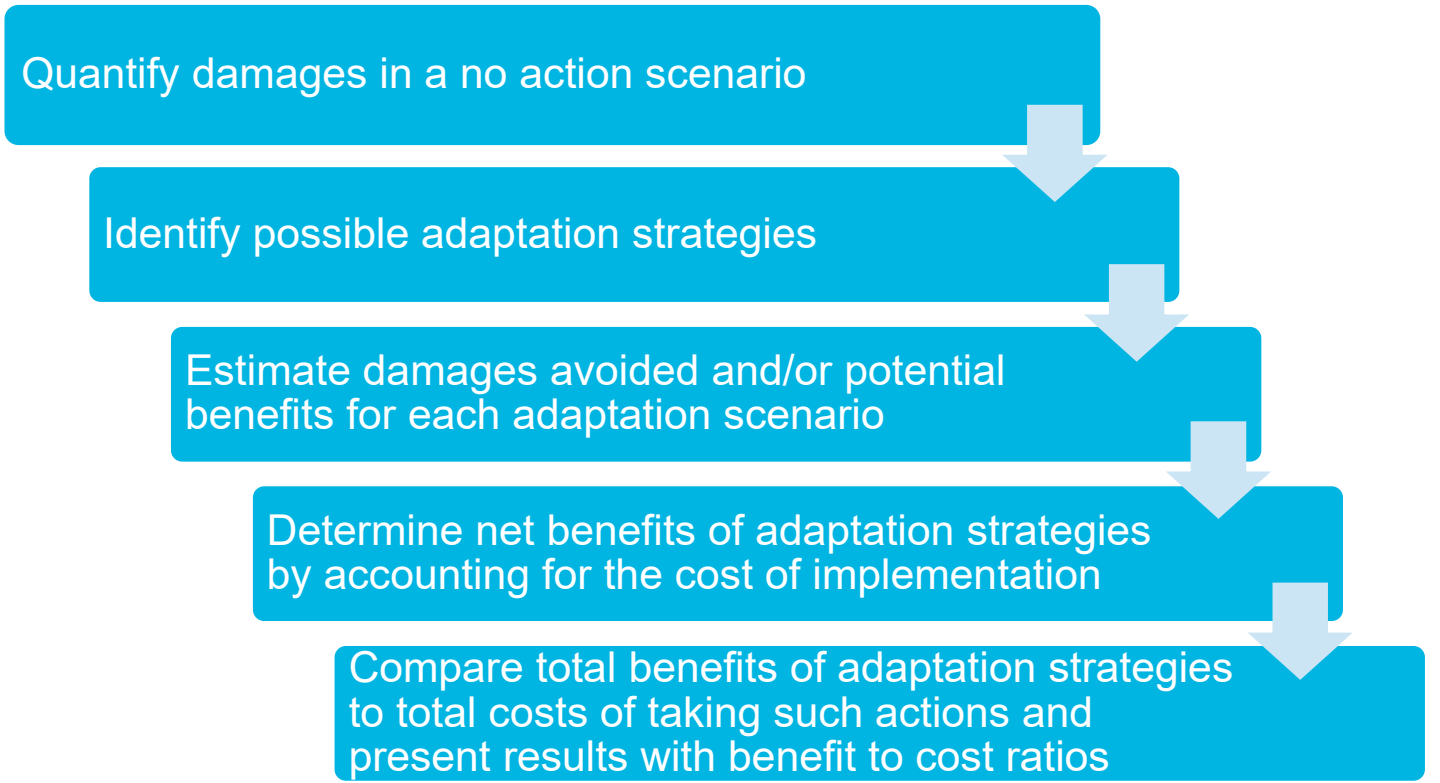
Presentation Overview

- Economics Scope
- Economics Workflow
- Key Analysis Concepts
- Hazard Scenarios and Adaptation Scenarios
- Categories of Impact Evaluated
- No Action Summary Results and Detailed Fiscal Results
- Avoided Losses from Adaptation
- Adaptation Costs
- Cumulative Benefit-Cost Analysis Considerations

Economics Scope

- Develop a *high level* understanding of the potential *magnitude* of economic and fiscal impacts from future coastal hazard conditions if no action is taken.
- Inform decision-making around the benefits and costs of actions that can be taken to support the people, businesses, and places that make Santa Barbara a world-class place to live, work, and recreate.
- Fulfill grant requirements.

Economics Work Flow



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Key Analysis Concepts

- Static built environment
- Snapshot vs cumulative impacts
- Temporary (storm) vs permanent (SLR + erosion) impacts
  - One-time vs reoccurring impacts
- Evaluation methods:
  - Economic damage (focused on real and personal property)
  - Economic impact (focused on business activity)
  - Economic value (focused on beach recreation)
  - Fiscal impact (focused on revenues secured by City)

Hazard Scenarios

- **2018 Conditions:** (1) Spring tide; (2) 100-year storm
- **2060 Conditions:** (1) Spring tide with 2.5 feet of SLR; (2) 100-year coastal storm with 2.5 feet of SLR
- **2100 Conditions:** (1) Spring tide with 6.6 feet of SLR; (2) 100-year coastal storm with 6.6 feet of SLR

Adaptation Scenarios

- **No Action:** Do nothing to mitigate the impacts of SLR and coastal storms
- **Protect:** Armor bluffs and build flood control to protect assets in place
- **Retreat/Protect Hybrid:** retreat public and private assets up to 25 feet of major roads then armor bluffs to protect major roads in place and preserve access along road/bluff top

Categories of Impact Evaluated

Impact Category	Temporary Storms*	Permanent Tidal and Erosion
Direct Property	Structure damage Content loss Cleanup costs	Market value loss* Real property value loss*
Displacement	Relocation costs Temporary shelter costs	Not evaluated
Business and Employment	Sales loss Wage loss	Sales loss Wage loss
Infrastructure	Not evaluated	Full replacement costs*
Fiscal	Property tax loss Sales tax loss TOT loss Waterfront Dept revenue loss	Property tax loss Sales tax loss TOT loss Waterfront Dept revenue loss
Non-Market	Not evaluated	Recreational value loss

Note: * = One-time impacts, otherwise recurring, annual impacts

Summary Results by Impact Type: No Action ($2018)

IMPACT TYPE	EXISTING CONDITIONS			2060 CONDITIONS			2100 CONDITIONS		
	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL IMPACTS	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL IMPACTS	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL IMPACTS
Direct Property	NA	$26.6 M	**$26.6 M**	$190.7 M	$16.2 M	$206.9 M	**$596.7 M**	$220.1 M	**$816.8 M**
Displacement	NA	$1.1 M	**$1.1 M**	NA	$0.7 M	$0.7 M	**NA**	$12.2 M	**$12.2 M**
Business	NA	$2.4 M	**$2.4 M**	$57.2 M	$0.4 M	$57.6 M	**$121.3 M**	$6.5 M	**$127.8 M**
Infrastructure	NA	NE	**$0.0 M**	$402.7 M	NE	$402.7 M	**$444.3 M**	NE	**$444.3 M**
Fiscal	NA	$0.7 M	**$0.7 M**	$15.1 M	$0.1 M	$15.2 M	**$23.1 M**	$1.3 M	**$24.4 M**
Non-Market	NA	NA	**$0.0 M**	$27.0 M	NA	$27.0 M	**$34.9 M**	NA	**$34.9 M**
TOTAL	NA	$30.8 M	$30.8 M	$692.8 M	$17.4 M	$710.2 M	$1220.2 M	$240.1 M	$1460.3 M

Direct Property Impact Breakdown (%)

DIRECT PROPERTY TYPE	EXISTING CONDITIONS		2060 CONDITIONS		2100 CONDITIONS	
	Tidal + Erosion Impacts	100-Year Storm Impacts	Tidal + Erosion Impacts	100-Year Storm Impacts	Tidal + Erosion Impacts	100-Year Storm Impacts
Public Property	NA	68%	92%	55%	96%	76%
Private Property	NA	32%	8%	45%	4%	24%

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Detailed Fiscal Impacts Results: No Action ($2018)

IMPACT TYPE	EXISTING CONDITIONS			2060 CONDITIONS			2100 CONDITIONS		
	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL IMPACTS	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL IMPACTS	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL IMPACTS
Property Tax Structure Loss	NA	$0.18 M	$0.18 M	$2.06 M	$0.10 M	$2.16 M	$5.63 M	$0.98 M	$6.61 M
Sales Tax Business Loss	NA	$0.04 M	$0.04 M	$0.87 M	$0.01 M	$0.88 M	$1.57 M	$0.08 M	$1.65 M
Sales Tax Beach Recreation Loss	NA	NA	$0.00 M	$0.06 M	NA	$0.06 M	$0.08 M	NA	$0.08 M
Total Sales Tax Loss	NA	$0.04 M	$0.04 M	$0.93 M	$0.01 M	$0.94 M	$1.65 M	$0.08 M	$1.72 M
TOT Business Loss	NA	$0.00 M	$0.00 M	$0.00 M	$0.00 M	$0.00 M	$2.40 M	$0.24 M	$2.64 M
TOT Beach Recreation Loss	NA	NA	$0.00 M	$0.21 M	$0.00 M	$0.21 M	$0.28 M	$0.00 M	$0.28 M
Total TOT Loss	NA	$0.00 M	$0.00 M	$0.21 M	$0.00 M	$0.21 M	$2.68 M	$0.24 M	$2.92 M
Waterfront Department Loss	NA	$0.45 M	$0.45 M	$11.91 M	$0.00 M	$11.91 M	$13.10 M	$0.00 M	$13.10 M
TOTAL	**NA**	**$0.68 M**	**$0.68 M**	**$15.10 M**	**$0.11 M**	**$15.21 M**	**$23.06 M**	**$1.30 M**	**$24.35 M**

Protect Scenario Impacts Avoided (%)

IMPACT TYPE	EXISTING CONDITIONS			2060 CONDITIONS			2100 CONDITIONS		
	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL CHANGE	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL CHANGE	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL CHANGE
Direct Property	NA	NA	NA	-98%	-100%	**-98%**	-95%	-100%	**-97%**
Displacement	NA	NA	NA	NA	-100%	**-100%**	NA	-100%	**-100%**
Business	NA	NA	NA	-83%	-100%	**-83%**	-91%	-100%	**-92%**
Infrastructure	NA	NA	NA	-98%	NE	**-98%**	-98%	NE	**-98%**
Fiscal	NA	NA	NA	-82%	-100%	**-82%**	-98%	-100%	**-98%**
Non-Market	NA	NA	NA	0%	NA	0%	-16%	NA	-16%
TOTAL	**NA**	**NA**	**NA**	**-93%**	**-100%**	**-93%**	**-94%**	**-100%**	**-95%**

Protect / Retreat Hybrid Scenario Impacts Avoided (%)

IMPACT TYPE	EXISTING CONDITIONS			2060 CONDITIONS			2100 CONDITIONS		
	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL CHANGE	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL CHANGE	Tidal + Erosion Impacts	100-Year Storm Impacts	TOTAL CHANGE
Direct Property	NA	NA	NA	-12%	-100%	-19%	-59%	-100%	-70%
Displacement	NA	NA	NA	NA	-100%	**-100%**	NA	-100%	**-100%**
Business	NA	NA	NA	-84%	-100%	**-84%**	-91%	-100%	**-92%**
Infrastructure	NA	NA	NA	-98%	NE	**-98%**	-97%	NE	**-97%**
Fiscal	NA	NA	NA	-69%	-100%	-70%	-88%	-100%	-88%
Non-Market	NA	NA	NA	-3%	NA	-3%	-16%	NA	-16%
TOTAL	**NA**	**NA**	**NA**	**-69%**	**-100%**	**-69%**	**-75%**	**-100%**	**-79%**

Adaptation Costs by Decade ($2018)

DECADE	PROTECT SCENARIO				PROTECT / RETREAT HYBRID SCENARIO			
	Capital	Capital / Maintenance	Maintenance	TOTAL COSTS	Capital	Capital / Maintenance	Maintenance	TOTAL COSTS
2020	$0.0 M	$0.0 M	$0.0 M	**$0.0 M**	$1.0 M	$0.0 M	$0.1 M	**$1.1 M**
2030	$1955.9 M	$128.3 M	$5.8 M	**$2089.9 M**	$67.8 M	$11.6 M	$2.3 M	**$81.7 M**
2040	$0.0 M	$0.0 M	$7.5 M	**$7.5 M**	$0.0 M	$0.0 M	$7.5 M	**$7.5 M**
2050	$0.0 M	$0.0 M	$10.7 M	**$10.7 M**	$0.0 M	$0.0 M	$10.7 M	**$10.7 M**
2060	$361.3 M	$107.1 M	$2321.1 M	**$2789.5 M**	$649.8 M	$107.1 M	$227.3 M	**$984.2 M**
2070	$0.0 M	$0.0 M	$34.3 M	**$34.3 M**	$0.0 M	$0.0 M	$34.3 M	**$34.3 M**
2080	$0.0 M	$65.8 M	$426.2 M	**$492.0 M**	$0.0 M	$65.8 M	$293.7 M	**$359.4 M**
2090	$0.0 M	$0.0 M	$2086.3 M	**$2086.3 M**	$0.0 M	$0.0 M	$93.5 M	**$93.5 M**
2100	$119.4 M	$162.6 M	$579.0 M	**$860.9 M**	$202.3 M	$162.6 M	$445.4 M	**$810.3 M**
TOTAL	**$2436.6 M**	**$463.7 M**	**$5470.9 M**	**$8371.2 M**	**$920.8 M**	**$347.0 M**	**$1114.8 M**	**$2382.7 M**

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Cumulative Benefit-Cost Analysis Considerations

Analysis Steps:

- Account for the likelihood of modeled events occurring year-over-year across the period of analysis (2018-2100)
- Apply financial discounting techniques to relate future benefits and costs to present value terms

Results:

- **For the No Action Scenario**, Business and Non-Market represent nearly 75% of cumulative impacts, with Direct Property, Infrastructure and Fiscal equally accounting for the rest of losses (8-10% per impact type)

- **Protect scenario not cost-effective,** benefit-cost ratio of approximately 0.2
- **Protect/Retreat hybrid scenario cost-effective,** benefit-cost ratio of approximately 1.1

Thanks for your time!

Questions?

Contact: aaron.mcgregor@aecom.com

November 19, 2019

Questions or Comments?

- Website: www.SantaBarbaraCA.gov/SLR
- Contact: Melissa Hetrick, Community Development Department mhetrick@SantaBarbaraCA.gov